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Shadow spectral imaging of absorbing layers in a transversely heated graphite atomizer Part 1. Analyte atoms

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Abstract

The technique of shadow spectral imaging was used to investigate dynamics of formation and dissipation of Ag, In, Ga, Bi, Mn, Cu and Tl atomic layers in a transversely heated graphite tube atomizer (THGA) with and without integrated platform under gas-stop and gas-flow conditions. It is shown that non-uniform heating of the tube walls and platform surface in the radial cross section is the main reason for analyte transfer from atomizer bottom to less heated sides of the tube and platform before atomization temperature is reached. This transfer in the atomizer transverse cross section can be an additional factor that reduces matrix interferences in the THGA. In all the investigated cases, the atomic absorbing layers are not spatially uniform. Absorbance gradients grow up to 0.2 mm^{-1} even in the case of chemically inert silver atomization. Inverse atomization of In, Bi, Ga and Tl when atoms first appear in the atomizer's upper part was detected in THGA with platform. The effect of the internal gas flow on the spatial structure of analyte atoms is less pronounced in the transversely heated atomizer as compared to the end-heated furnaces.

Keywords: Atomic absorption spectrometry; Transversely heated graphite atomizer; THGA; Shadow spectral imaging; Atomic vapors

1. Introduction

It is well known that spatial uniformity of an absorbing layer is a prerequisite for correct absorbance measurements by conventional atomic absorption spectrometers [1,2]. However, numerous investigations carried out in different laboratories have clearly shown spatial non-uniformity of atomic and molecular layers in the radial cross section of graphite furnaces. An overview of these investigations is presented in [3,4]. The degree of vapor non-uniformity depends on physical chemical properties of analyte and matrix, design of the furnace, and also on the type and flow characteristics of the sheath gas. Also, spatial pattern of the same element depends significantly on the atomization site (wall or platform). Many kinds of non-uniformities have been detected in the radial cross section of graphite furnaces: noble metals like Ag and Au display "normal" distribution at any moment of atomization with analyte number density monotonically decreasing when going from furnace bottom to the top, while the spatial distribution of In, Ga, Tl and Ge is inverse with analyte number density increasing when going from the platform where the sample is initially located to the top. Spatial distributions of molecules and finely dispersed condensed particles that are responsible for nonspecific absorbance turned out to be even more abnormal: In, Ga and Al suboxides were distributed extremely non-uniformly and located close to the platform and the cloud of condensed particles took the shape of a donut in the furnace gas phase. The shape of all these distributions can be altered significantly by experimental conditions and the composition of the sample matrix. The key reasons for non-uniformities are reactivity

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